where the subject can be further investigated if necessary. In some large industrial works the head of any department can obtain such information through the works library in which a staff exists to supply it. Something of the same kind is wanted on a national basis; and the most useful purpose the Department of Scientific and Industrial Research could perform would be to institute such a central bureau.

The institution of a great clearing-house for scientific facts and industrial needs would be of supreme value to national development. Intimate connection must be established between workers in the fields of science and industry in order to bridge the gap which exists between scientific investigation and industrial application; and a sure way of accomplishing this is through an efficient and easily accessible intelligence bureau. It is to what has been termed the science of the use of science that the Germans owe to a great extent the place they have attained in the industrial world, though they have often employed unscrupulous means to reach their end. Every large industrial concern should have its own information and records department, which should be planned on the same lines as the central bureau. A few months ago M. Paul Otlet, director of the International Institute of Bibliography at Brussels, published in the Bulletin of the French Société d'Encouragement pour l'Industrie nationale a scheme for an international bureau of this kind having as its functions the collection, classification, and dissemination of all information available which will tend to facilitate or develop industry. Without waiting for this scheme to be established, a beginning should be made with a national clearing-house having like intentions.

Something has been done in this direction at public libraries in different parts of the country. At Coventry, for example, the staff of the Central Library invites inquiries for information, whether made personally, or by letter, or by telephone, and lists of original papers and books dealing with particular technical subjects are issued in printed form and circulated widely among manufacturers and others interested in them. The Glasgow libraries are also issuing lists of works on various technical subjects; and the Library Association, in a report referred to last week (p. 257), points out that a national lending library of books suitable for giving assistance in scientific and technological research would be of the greatest advantage to technologists.

At the annual meeting of this association, held at the beginning of October, Dr. Addison, the Minister of Reconstruction, said that one of the features of the programme which appealed to him was this movement for the formation of technical and commercial libraries and for the setting up of research libraries to suit the particular needs and industries of various districts. It is, however, not sufficient to provide for local needs; there should also be a central library and bureau which would make the position of knowledge in any scientific or technical subject available to any inquirer. Such an institution could be made self-supporting after a time, for manufacturers would not hesitate to pay fees for information required by them to develop their industries. We look to Dr. Addison and the Advisory Council for Scientific and Industrial Research to provide this centralised means of assisting industrial development.

THE ORDER OF NATURE.

The Order of Nature. By Prof. L. J. Henderson. Pp. iv+234. (Cambridge, Mass.: Harvard University Press; London: Humphrey Milford, Oxford University Press, 1917.) Price 6*s.* 6*d.* net.

PROF. L. J. HENDERSON, of Harvard, is well known for his important experimental work in bio-chemistry. He is also the author of a previous book entitled "The Fitness of the Environment," in which the inherent fitness for life of the actual physical and chemical world is pointed out in detail. In the present work he has followed up and developed the same thesis.

The first three chapters, beginning with an analysis of Aristotle's distinction between "final" and "efficient" causes, are devoted to an historical survey of ideas on the teleological appearance, not only of organic structure, but of Nature as a whole, considered as a fitting environment for life. Up to the middle of the nineteenth century the fact of a teleological determination of Nature as a whole was admitted by nearly all leading thinkers, however variously this fact was explained. The same admission appears in some of Darwin's writings; but since the publication of the theory of natural selection the teleological conception of Nature has almost disappeared from scientific thought. It has come to be assumed that the reason why the physical and chemical environment appears to be specially fitted for life is simply that life has, by natural selection, been so moulded as to fit its environment. Against this conclusion the main chapters of the book are directed; and the argument is the more remarkable and original since the author accepts without question the theory of natural selection. His discussion of Spencer's conception of evolution is perhaps specially luminous.

The reasoning is based entirely on the general characteristics of life from the point of view of physical chemistry, and particularly from that of Willard Gibbs's analysis of the conditions of stability and variability of physico-chemical systems, living organisms being regarded as such

© 1917 Nature Publishing Group

systems. The difficulty in forming any clear conception at present of the physico-chemical origin of life, or of completely understanding life as a physico-chemical system, is fully acknowledged, but is passed by as presenting a problem which cannot yet be solved owing to the imperfection of existing knowledge.

The general scope of Prof. Henderson's argument, which is presented with much interesting detail, is as follows. The actual distribution of properties among the actual elements, and particularly carbon, oxygen, and hydrogen, is of such a nature as to give a maximum of freedom in the process of evolution.

> So far as the known properties of matter are concerned, considering them both quantitatively and qualitatively, every other sensibly different distribution of the properties among the elements would involve great restrictions. Thus conditions are actually established (relatively to other imaginable arrangements of the properties of matter) for the existence of the greatest possible number, diversity, and duration of systems, phases, components, and activities. So it comes about that, in every physical respect, the process of evolution is free to produce more rather than less.
>
> It cannot be that the nature of this relationship is, like organic adaptations, mechanically conditioned. For relationships are mechanically conditioned in a significant manner only when there is opportunity for modification through interaction. But here the things related are supposed to be changeless in time, or, in short, absolute properties of the universe. According to the theory of probabilities, this connection between the properties of matter and the process of evolution cannot be due to mere contingency. Therefore, since the physico-chemical functional relationship is not in question, there must be admitted a functional relationship of another kind, somewhat like that known to physiology. This functional relationship can only be described as teleological.

The author is content with the conclusion that the universe has a teleological arrangement in relation to organic evolution. He carefully avoids all theological inferences, and leaves us with teleological arrangement as an ultimate and mysterious empirical fact. Granted his initial assumption that what we call Nature is nothing but a physico-chemical universe in the sense at present currently accepted, we do not see how his general argument can be shaken. It is not only strikingly original, but also very cogent, and seems certain to exercise much influence on the general trend of philosophical thought in connection with natural science.

If we may offer any criticism of the argument it is this. The conception of a living organism in connection with its environment as a physico-chemical system in the sense of current physical chemistry fails to express the facts of biology. If we call it a system it is a system in which relationship to the whole determines both the constitution and the activities of the parts. These parts and activities, including biological environment, are a function of their relation to the other parts, and therefore to the whole: hence biology deals, not merely with the "efficient" causes of ordinary physics and chemistry, but also with what Aristotle called "final" causes. In biological facts teleology is revealed as immanent in Nature—as of its essence, and no mere accident, and as inherent in environment, and not merely in what we ordinarily distinguish as the bodies of organisms. It seems to follow that the detailed extension of biological conceptions to what we at present regard as the inorganic world can only be a matter of the further extension of knowledge. We have not at present the data for this extension: hence the teleological constitution of the inorganic world can only appear to us as a mysterious empirical fact, and cannot appear otherwise when we assume at the outset that the universe is composed of material units as eternal and unchangeable independent entities. The question inevitably raised by Prof. Henderson's book is whether this assumption is valid, and whether we must not look to the future penetration of physics and chemistry by conceptions akin to those of biology. In the latter case teleological reasoning will take a natural place in the physical sciences.

J. S. H.

HIGHER ALGEBRA AND DYNAMICS.

(1) *A First Course in Higher Algebra.* By Prof. Helen A. Merrill and Dr. Clara E. Smith. Pp. xiv + 247. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 6*s*. 6*d*. net.

(2) *Problems in Dynamics (with Full Solutions) for the B.A. Students (Pass and Honours) of the Indian Universities.* By Atma Ram. Pp. 245 + diagrams 16. (Anarkali, Lahore: Atma Ram and Sons.) Price 3*s*.

(1) Of these two books, the first is interesting as being the work of two American ladies who are colleagues in the same institution. Each of the authors is a Ph.D., and for this and other reasons we may surmise that they received a good part of their training in Germany. They are keenly interested in their subject, have studied its history, and are acquainted with some of its most recent aspects. Thus equipped, they have chosen for their main topics rational, irrational, and (ordinary) complex numbers, logarithms, theory of equations, and elementary calculus. Each chapter is headed by an appropriate quotation; there are a number of historical notes, and some references are made to more advanced textbooks. All this is to the good, and the authors, on the whole, have carried out their programme successfully.

But, unless we are mistaken, this is their first book, and, like all first books, it has the inevitable faults of the beginner, the chief of these being a want of clearness, or a want of detail, just where they are most required. To illustrate this, we will turn to the chapter on the theory of equations. In their "proof" of Descartes' rule of signs they put down the usual +, −, ± diagram, and then say: "The original polynomial had five changes of sign, while the resulting one has at least six, even when the ambiguous signs are so

© 1917 Nature Publishing Group